

## THE 1991 AVIRIS/POLDER EXPERIMENT IN CAMARGUE, FRANCE

N 9 4 3 1 6 6 9 1  
3

F. Baret<sup>1</sup>, C. Leprieur<sup>2</sup>, S. Jacquemoud<sup>1</sup>, V. Carrère<sup>3</sup>, X.F. Gu<sup>4</sup>, M. Steven<sup>4</sup>,  
V. Vanderbilt<sup>5</sup>, J.F. Hanocq<sup>1</sup>, S. Ustin<sup>6</sup>, G. Rondeaux<sup>5</sup>, C. Daughtry<sup>7</sup>, L. Biehl<sup>8</sup>,  
R. Pettigrew<sup>5</sup>, D. Modro<sup>5</sup>, H. Horoyan<sup>1</sup>, T. Sarto<sup>5</sup>, C. Despontin<sup>1</sup>,  
H. Razafindraibe<sup>1</sup>

<sup>1</sup>INRA Bioclimatologie, BP 91, 84140 Montfavet Cedex, France,

<sup>2</sup>LERTS, 18 Av. Ed. Belin, 31 055 Toulouse cedex, France,

<sup>3</sup>JPL, MS 180-701, 4800 Oak Grove Drive, Pasadena CA 91109, USA,

<sup>4</sup>Nottingham university, Dept. Geog., NG7 2RD, Nottingham, England,

<sup>5</sup>NASA/Ames R.C., MS 242-4, Moffet Field, CA 94 035, USA,

<sup>6</sup>Dept. Land Air Water Res., Unic. Calif. Davis, 95 616, USA,

<sup>7</sup>USDA/ARS, RSL., Buid. 1, BARC-West, Beltsville, Maryland 20705, USA,

<sup>8</sup>Purdue University, West Lafayette, Indiana 47907, USA.

### 1. INTRODUCTION.

Airborne campaigns during the eighties have provided high spectral resolution data, collected with imaging instruments such as AIS, AVIRIS, FLI, CAESI and ISM, in order to investigate the relationship with canopy biophysical characteristics. The statistical approaches used to analyze these data do not allow investigation of the causality and the applicability of the observed correlations. Further, statistical studies have demonstrated the high degree of redundancy of the spectral information (Ferns et al, 1984; Price, 1991 amongst many others). And for retrieving vegetation biophysical characteristics, few results demonstrate the real information gain attributable to the high spectral resolution capability as compared to the use of a few wide wavelength bands.

With several new imaging spectrophotometers scheduled for launch during the next 10 years (MERIS, MODIS, HIRIS), progress in the description and understanding of the mechanisms that drive the spectral variation of canopy reflectance is required. Most of these new sensor systems will also have the capability to observe the target under differing view directions. The problem of the combination and the use of the synergy between both the spectral and the directional sources of canopy reflectance variations has to be addressed.

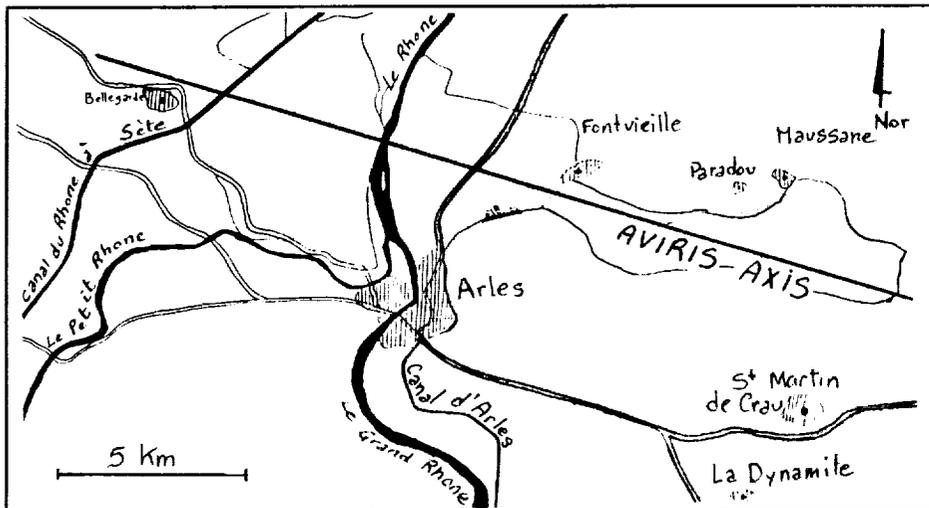
Apart from the atmospheric effects, the spectral variation of the light reflected by canopies originates from the leaves, the soil or the other vegetation elements such as branches and fruits. At leaf level, both diffuse reflectance and transmittance may be simulated by simple models (Jacquemoud and Baret, 1990), although no accurate information exists on the absorption features of the biochemicals (except water) in the 900-2500nm wavelength range. Many models mimic the directional variability of canopy reflectance at a given wavelength (see the review by Goel, 1988 for example). Combining a leaf spectral model with a canopy directional model provides a powerful tool to analyze this problem. Some of us have initiated such a study (Baret et al, 1991, Jacquemoud, 1992), but our approach and theory remain to be tested using canopy data with their complexity, associated experimental error, and atmospheric effects.

**Acknowledgements.** This study has been funded by the PNTS (France), the PACA regional council, and was part of the 1991 NASA MAC Europe campaign. Many thanks also to the LOA and JPL teams who were participating to the simultaneous AVIRIS, POLDER and SPOT calibration experiments.

The main objective of the 1991 POLDER/AVIRIS experiment in Camargue was to provide a consistent data set over various canopies in order to test the applicability of the theory. The experiment, part of the 1991 MAC Europe experiment, involved simultaneous data collection using two sensors: AVIRIS (Vane, 1987) and POLDER (Deschamps et al, 1990) which measures the bidirectional and polarization properties of the targets at 670 and 880nm wavebands.

### 3. THE EXPERIMENT

The topographically flat flightline, located near the Camargue region in the south of France, included diverse crops planted in fields having dimensions from 100 to 500m.



#### 3.1. The flights

The altitude of each sensor, 20,000m for AVIRIS flown on the NASA ER-2 and 3,000m for POLDER on the ARAT airplane, provided a ground spatial resolution of approximately 20m for each sensor. Simultaneous data were collected on June 24, 1991. In addition POLDER data were collected on 18, 19, and 21 June 1991 and AVIRIS data on July 16, 1991. The POLDER flights were designed to sample the directional variability due to both sun and view orientation.

#### 3.2. The ground measurements.

The characteristics of the atmosphere, monitored during collection of aircraft data, will allow retrieval of calibrated reflectance values. Retrieval will be facilitated by the availability of additional atmospheric data collected at the AVIRIS/SPOT calibration experiment at La Crau (about 30Km distance from our test sites). Three types of sunphotometers (Reagan, Cimel, spectral hygrometer) were used to measure solar irradiance throughout the day. During AVIRIS flights, the reflectance of two contrasted fields was recorded using SPOT simulation Cimel radiometers and a spectrophotometer. These measurements will provide tests of the accuracy of atmospheric corrections.

The ground measurements were designed to provide information about canopy biophysical parameters. Two data sets were gathered:

One **intensive data set** included 28 individual fields planted primarily in sunflower, corn, sorghum and rice. On each field, the leaf area index, the fresh and dry

biomass and its partition between leaf and stem were measured. A subsample of the leaves was later analyzed for chlorophyll, accessory pigments and biochemical constituents such as lignin, starch and proteins. Other characteristics such as the plant height, row orientation, vegetation coverage, soil surface characteristics were also noted. On 21 of the 28 plots, the zenithal variation of the gap frequency was evaluated using the LAI2000 device developed by LiCor. This measurement is particularly important in radiative transfer models and allows computation of the PAR balance for the canopies. Except for sunflower canopies, the leaf area index computed from gap frequency data showed good agreement with LAI values which were directly measured. (The heliotropism common to sunflower canopies might violate the hypotheses that leaves are distributed randomly in azimuth.) Optical properties of the leaves were measured using both laboratory (Varian Cary D17) and field portable spectrophotometers.

The second, **extensive data set**, which includes per field species information for the entire flightline, was developed during an exhaustive, ground level enquiry. This information will be available for resolving questions linked to the spatial scale.

## 5. CONCLUSION

This experiment will provide a consistent data set which includes the spectral, directional and polarization variations of canopy reflectances. The next step in the data processing is to build a data base for the 28 plots which contains the atmospherically corrected ground level reflectances linked to the biophysical measurements of the canopies. This will permit us to apply and test the relationships, developed during model simulation, to aircraft data. Ultimately, results from this experiment will allow better estimates of plant canopy biophysical properties through improved extraction of the spectral, directional and polarization information contained in data collected by spaceborne sensors.

## 6. REFERENCES

- Baret F., Jacquemoud S., Leprieur C., Guyot G., 1992.** Modelled analysis of the biophysical nature of spectral shifts. Accepted for Remote Sens. Environ.
- Deschamps P.Y., Herman M., Podaire A., Leroy M., Laporte M., Vermande P., 1990.** A spatial instrument for the observation of polarization and directionality of earth reflectances: POLDER. in IGARSS'90 conf. proc., Washington D.C., USA.
- Ferns, D.C., Zara J.C., Barber J., 1984.** Application of high resolution spectroradiometry to vegetation. Photogram. Eng. Remote Sens., 50(12):1725-1735.
- Goel N.S., 1988.** Models of vegetation canopy reflectance and their use in estimation of biophysical parameters from reflectance data. Remote Sens. Reviews, 4(1).
- Jacquemoud S., Baret F., 1990.** PROSPECT: a model of leaf optical properties spectra. Remote Sens. Environ. 34:75-91.
- Jacquemoud S., Baret F., 1991.** Estimation des parametres biophysiques d'un couvert vegetal par inversion d'un modele de reflectance sur des donnees haute resolution spectrale. Workshop "Structure du couvert vegetal et climat lumineux. Methodes de caracterisation et applications", 23-27 Sept.,Chateau de Saumane, France.
- Price J.C., 1990.** On the information content of soil spectra. Remote Sens, Environ. 33:113-121.
- Vane G., 1987.** Airborne Visible/Infrared Imaging Spectrophotometer: Description of the sensor, ground data, processing facility, laboratory calibration and first results. JPL publication 87-38.